

DRL 175

DOE/JPL-956205-84/17
Distribution Category UC-63

Quarterly Technical Progress Report

No. 6329-24

on the

DEVELOPMENT OF METALLIZATION PROCESS

FSA Project, Cell and Module Formation Research Area

For the Period Ending

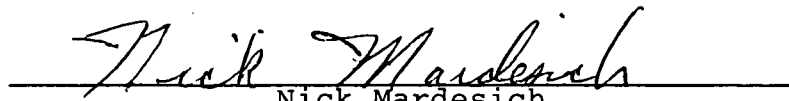
March 31, 1984

Contract 956205

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July 1984

The JPL Flat Plate Solar Array Project is sponsored by the U.S. Department of Energy and forms part of the Solar Photovoltaic Conversion Program to initiate a major effort toward the development of low-cost solar arrays. This work was performed for the Jet Propulsion Laboratory, California Institute of Technology by agreement between NASA and DOE.

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ABSTRACT/SUMMARY

New pastes were evaluated that contained additives to aid in the silicon to metallization contact. None were completely successful. Pastes were evaluated using a heated stage SEM at Microscopy Research, Inc. This equipment shows promise for future evaluations.

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Section 1.0

INTRODUCTION

The objective of this contract is the optimization, evaluation, and demonstration of a novel metallization applied by a screen printing process. The process will be evaluated on both CZ and non-CZ silicon wafers.

Section 2.0

TECHNICAL DISCUSSION

A series of experiments were done using pastes modified with indium resinate solution A2307 (Englehard-Electro Metallics, East Newark, NJ) and silver resinate solution 9144. Pastes E, J, and L were modified by adding 1% by weight of the resonates. The cells were processed as usual and then sintered at 650°C for 5 minutes in H₂. The J paste showed the best results with indium resonate added. Figures 1-4 show the light and dark IV curves for the best two cells using indium and silver resonates respectively.

Further experiments using the J paste with indium resonate at higher sintering temperatures produced better cells. The best cell was produced by sintering at 700°C for 5 minutes. Figures 5 and 6 show the light and dark curves of this cell. The production of good cells using this process was not reproducible about half of the cells produced were shunted as is shown in Figures 7 and 8. The better cells were still not solderable. Attempts to fine tune times and temperatures of sintering were not successful.

Three new pastes were received from Electrink formulated using silver neodecanoate. The formulations are shown in Table 1. An extensive matrix of experiments using prefire belt speed of 18-54"/min. at 400°C and sintering temperatures of 500-700°C

Figure 1

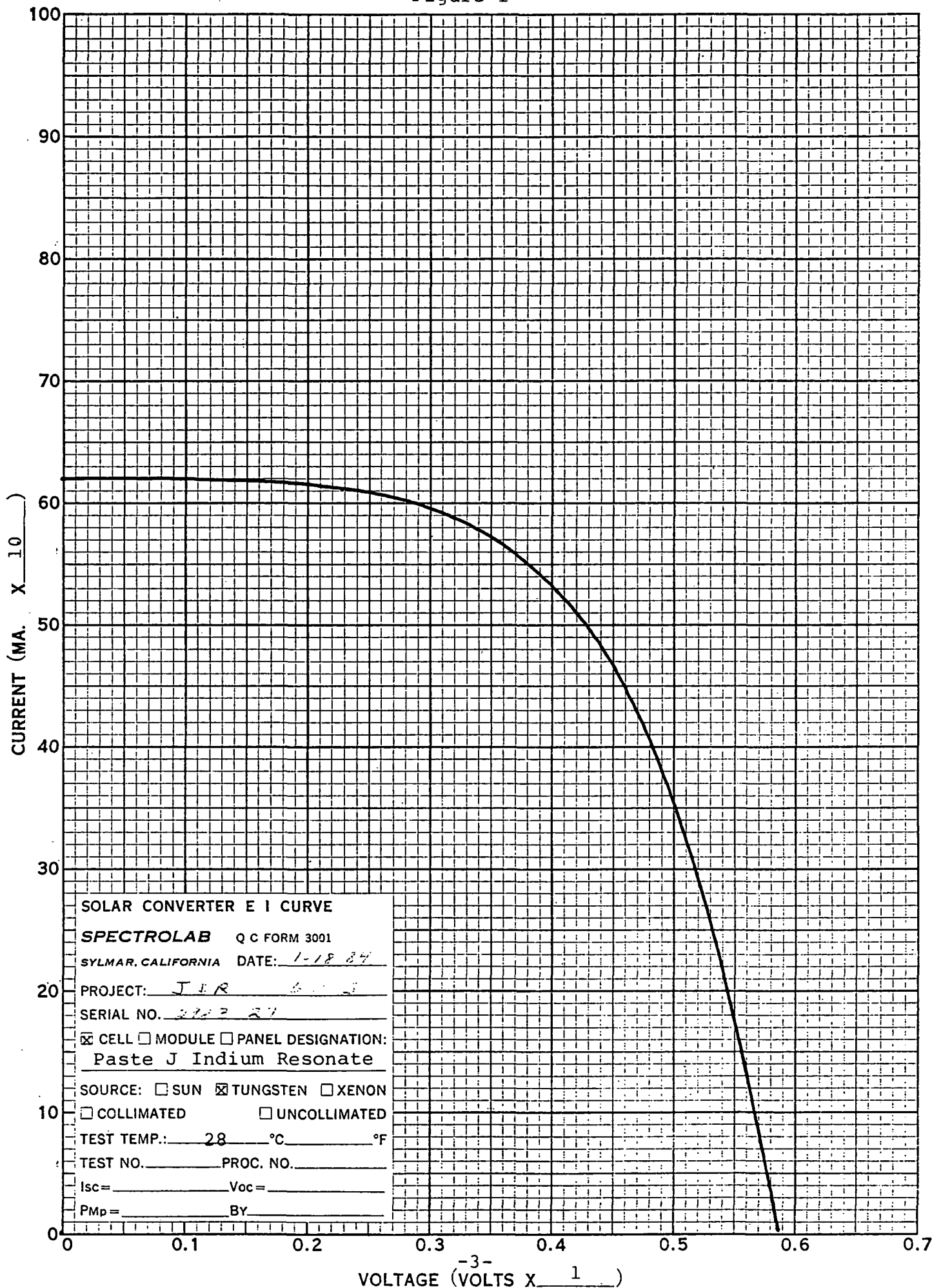


Figure 2

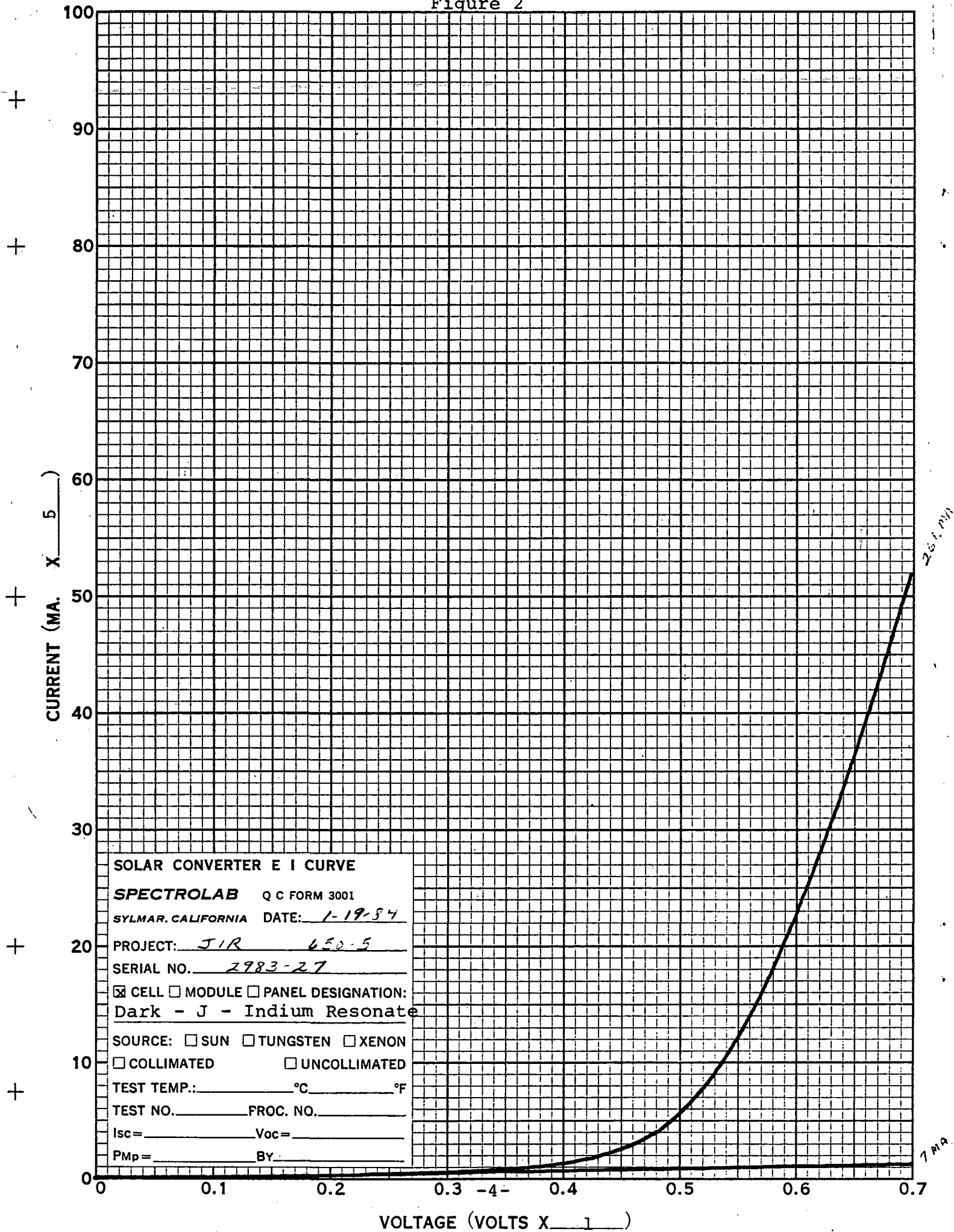


Figure 3

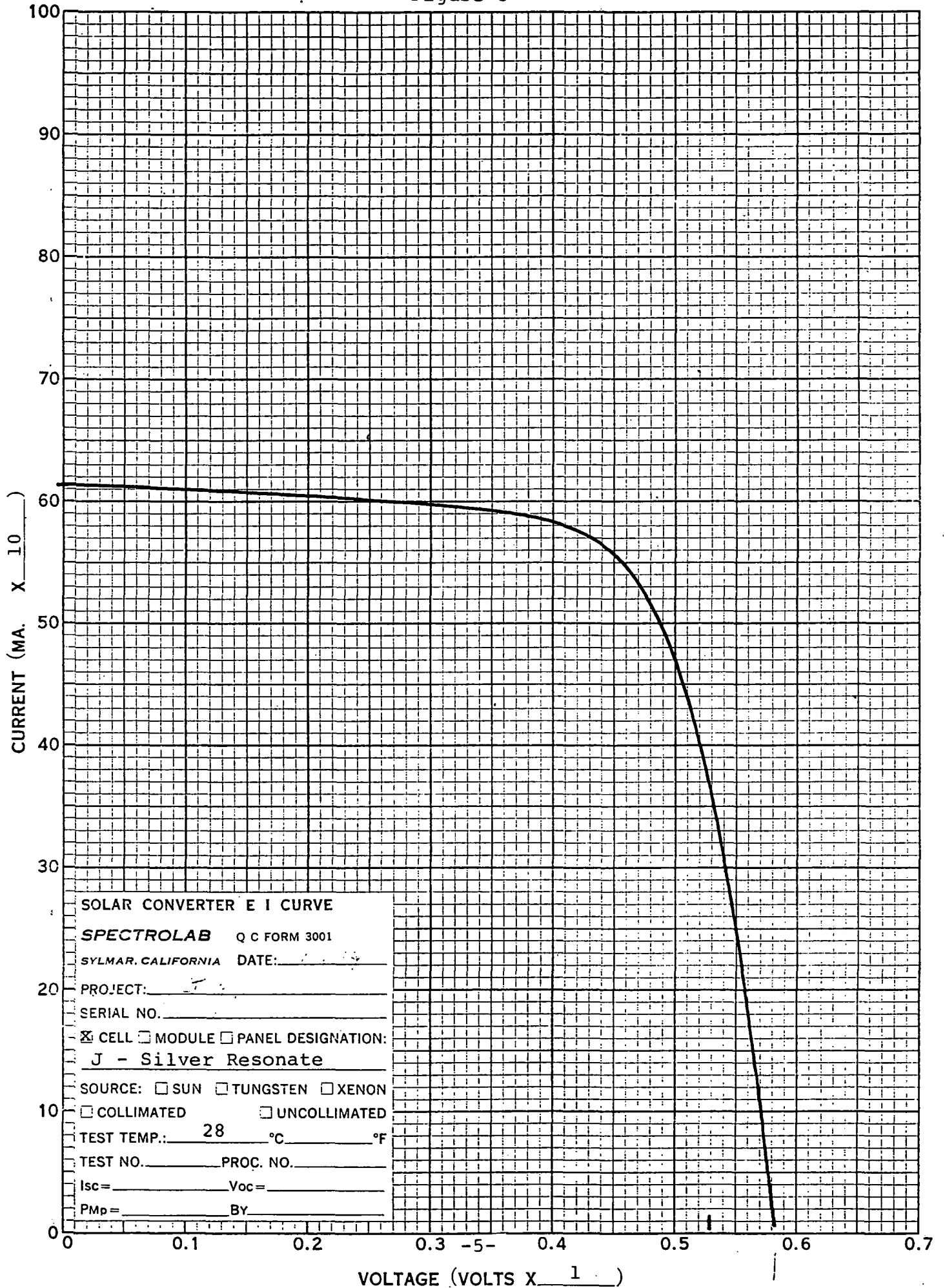


Figure 4

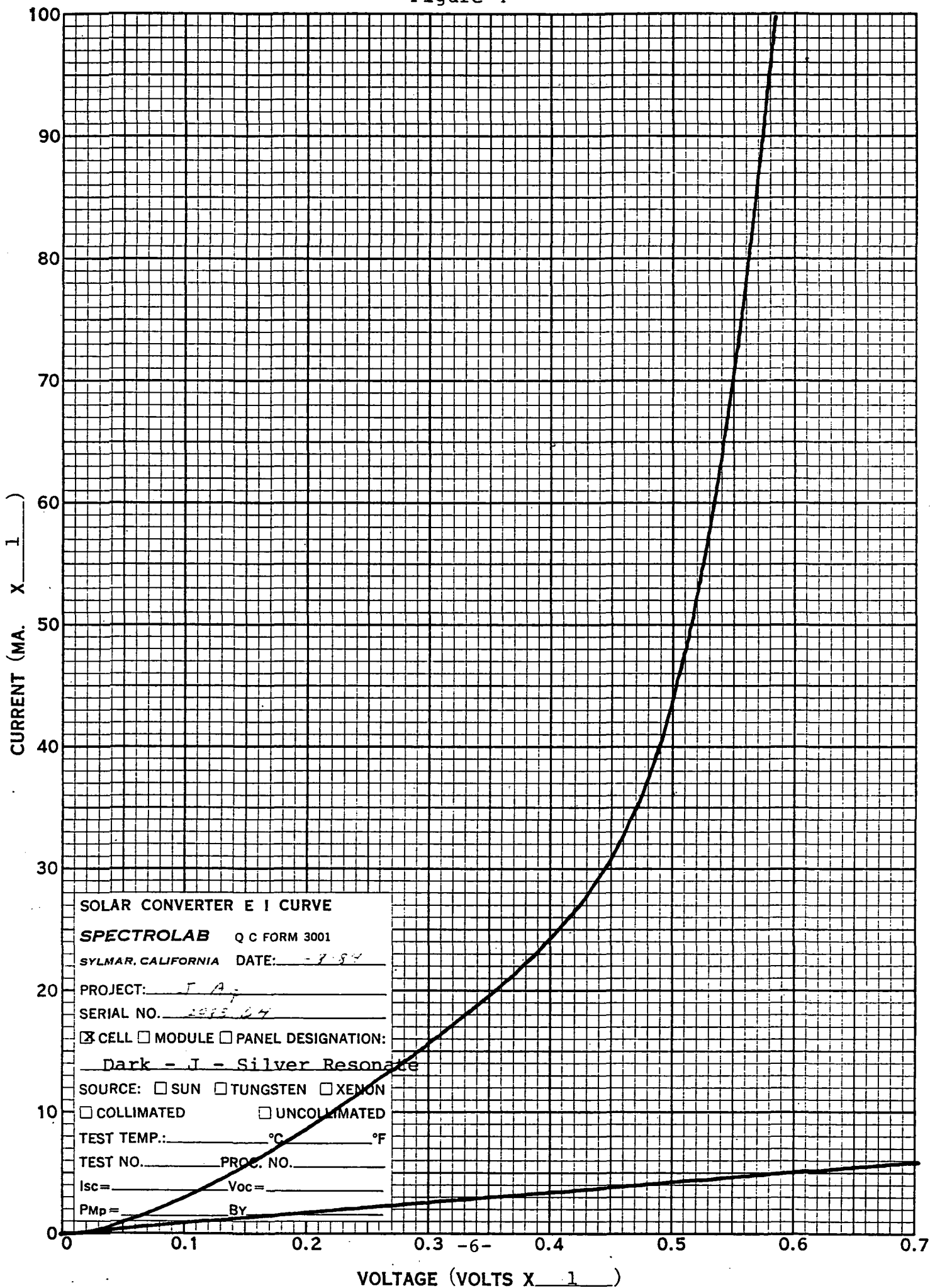


Figure 5

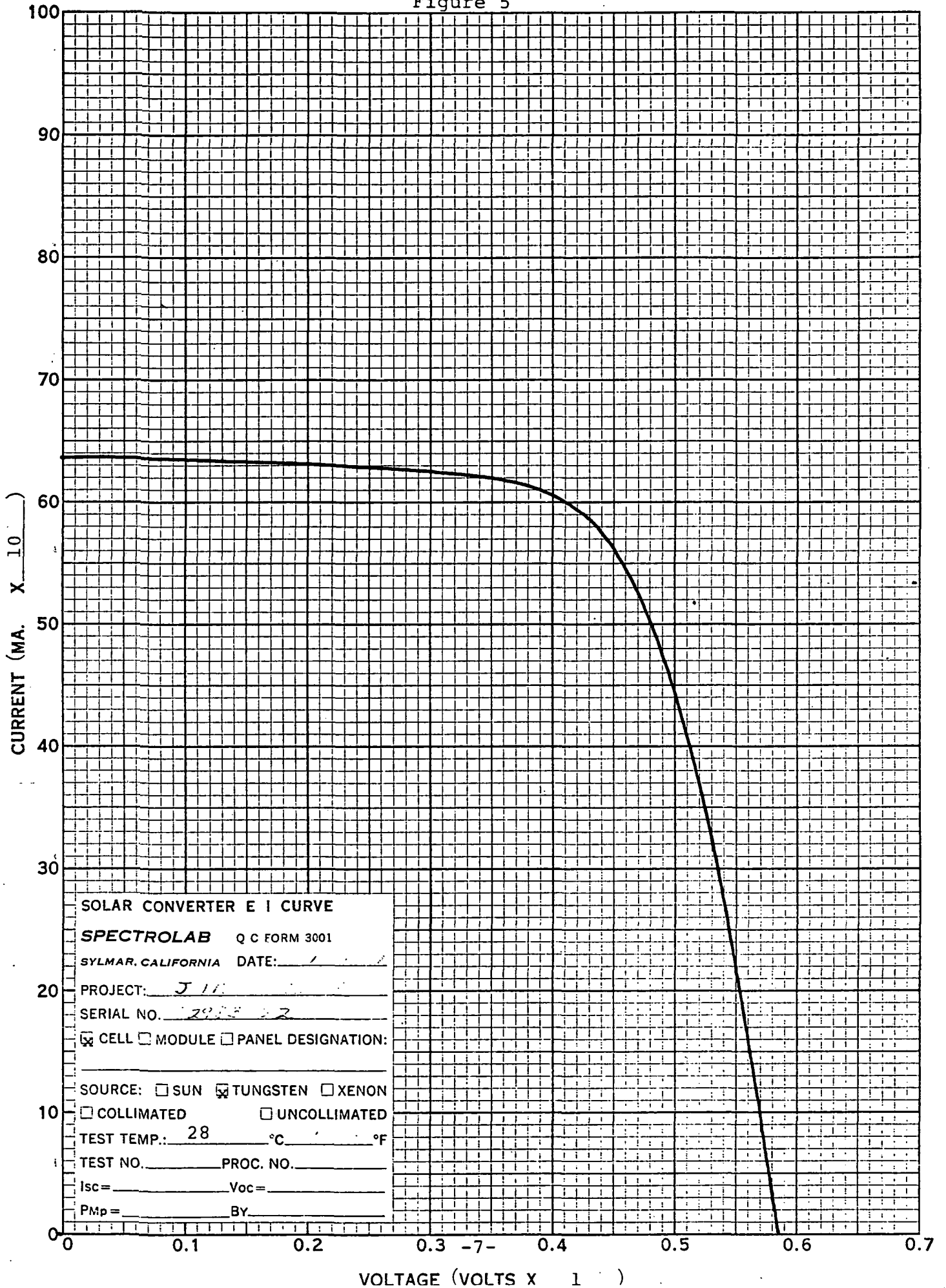


Figure 6

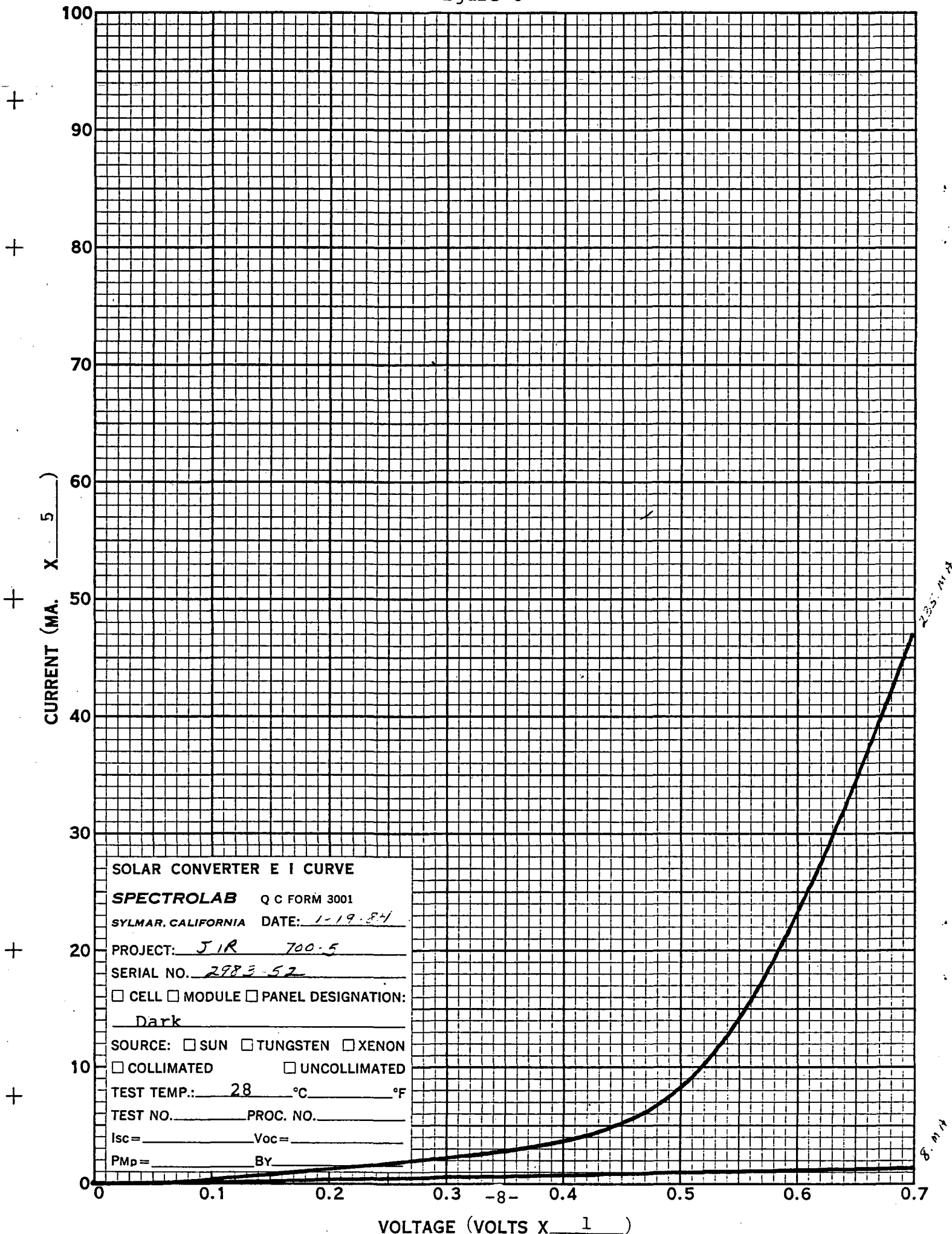


Figure 7

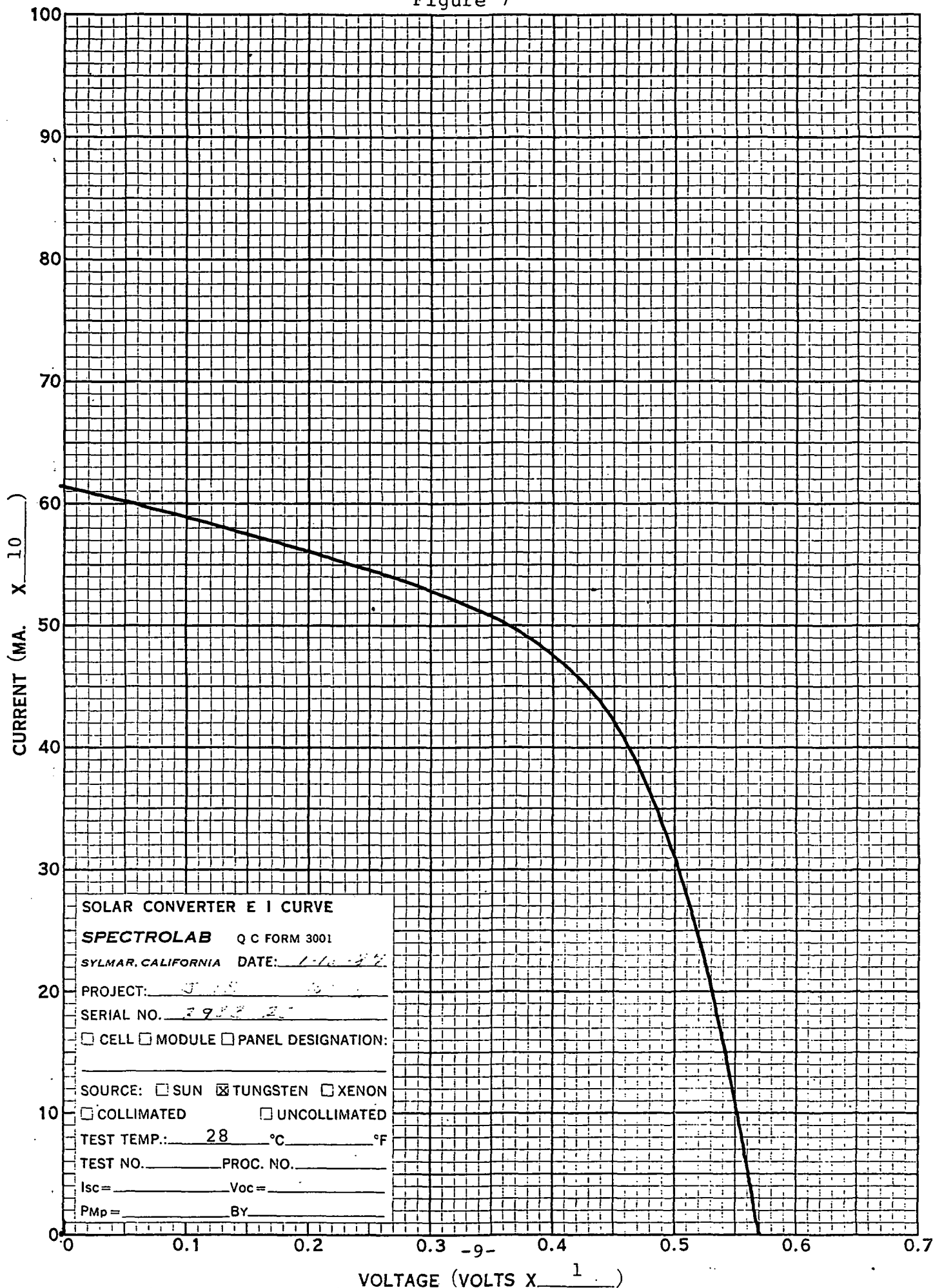


Figure 8

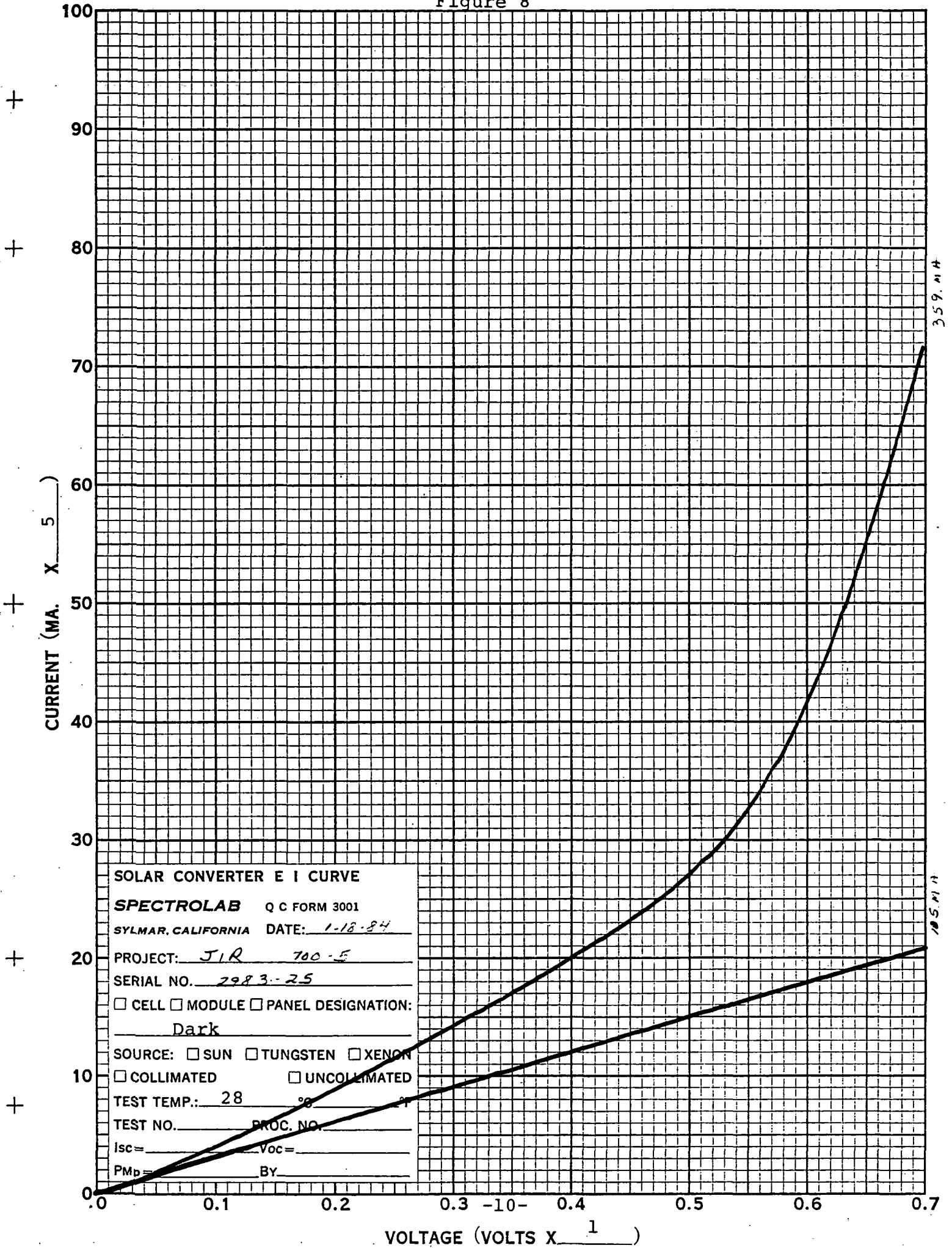


Table 1

NEW PASTES

Paste Composition

	P (F-83)	Q (F-84)	R (F-85)
TiH ₂	.40	.44	.40
Mo	14.70	15.99	14.70
Tin	58.78	63.91	58.78
Frit 450	6.46	0	0
Frit 494	0	0	6.46
Silver Neodecanoate Solution	5.48	5.48	5.48
Vehicle V38	14.18	14.18	14.18

Frit Composition

	<u>450</u>	<u>494</u>
K ₂ O	1.80	2.20
Na ₂ O	2.36	2.03
CaO	5.98	9.35
MgO	.32	.41
PbO	31.72	-
BaO	-	11.19
SrO	-	6.08
Al ₂ O ₃	3.50	5.09
B ₂ O ₃	13.76	7.99
SiO ₂	40.56	55.66
MP	827°C	771°C

Table 1 - Continued

Vehicle

α -Terpineol	43.62
Butyl Carbitol Acetate	43.62
Ethyl Cellulose N-14	9.76
Thixatrol ST	3.00

Materials Sources

<u>Material</u>	<u>Manufacturer Designation</u>	<u>Source</u>
Titanium Hydride (TiH_2)	77113	Alfa-Ventron, Danvers, MA
Molybdenum Powder	280/325	GTE Sylvania, Towanda, PA
Tin Powder 325 Mesh	00352	Alfa-Ventron, Danvers, MA
α -Terpineol	TX75	MCB Chem. Cincinnati, OH
Butyl Carbitol Acetate	-	Orange Co. Chem., Santa Ana, CA
Ethyl Cellulose	N-14	Hercules, Wilmington, DE
Thixatrol (thickener)	ST	NL Industries, Heightstown, NJ
Molybdenum Oxide (MoO_3)	102882	Alfa-Ventron, Danvers, MA
Titanium Resinate	9428	Englehard Ind., E. Newark, NJ
Trichloroethylene	-	Orange Co. Chem., Santa Ana, CA
Carbitol Acetate	-	Orange Co. Chem., Santa Ana, CA
Borane Pyridine	89150	Alfa-Ventron, Danvers, MA

was unsuccessful. The best cell is shown in Figures 9 and 10. Additionally, sintering was attempted by simple heating on a hot plate to cause the neodecanoate to act as sintering agent. This attempt was also unsuccessful.

A visit was made to Microscopy Research Laboratories, Inc. in Sommerville, New Jersey. This company has a controlled atmosphere SEM with a heated sample stage. Figure 11 shows a schematic of the instrument. The sample is placed in a sample holder and can be exposed to any gas at up to 5 torr while being heated and observed via the SEM. Video tapes of the SEM image are made as the sample is being heated.

A sample of the dried J paste was observed with the instrument. Initially an O_2 was introduced and the sample heated to $\sim 500^\circ C$, tin particles melted to globules at $\sim 230^\circ C$ but did not wet surrounding particles. The sample was returned to room temperature and H_2 introduced to the sample. The sample was heated slowly to $\sim 800^\circ C$. The sample showed minor changes until a temperature of $\sim 700^\circ C$ was reached when a rapid wetting and movement of the particles was seen. A well sintered continuous structure was formed. Figures 12 and 13 show SEM photographs before and after this redistribution.

Figure 9

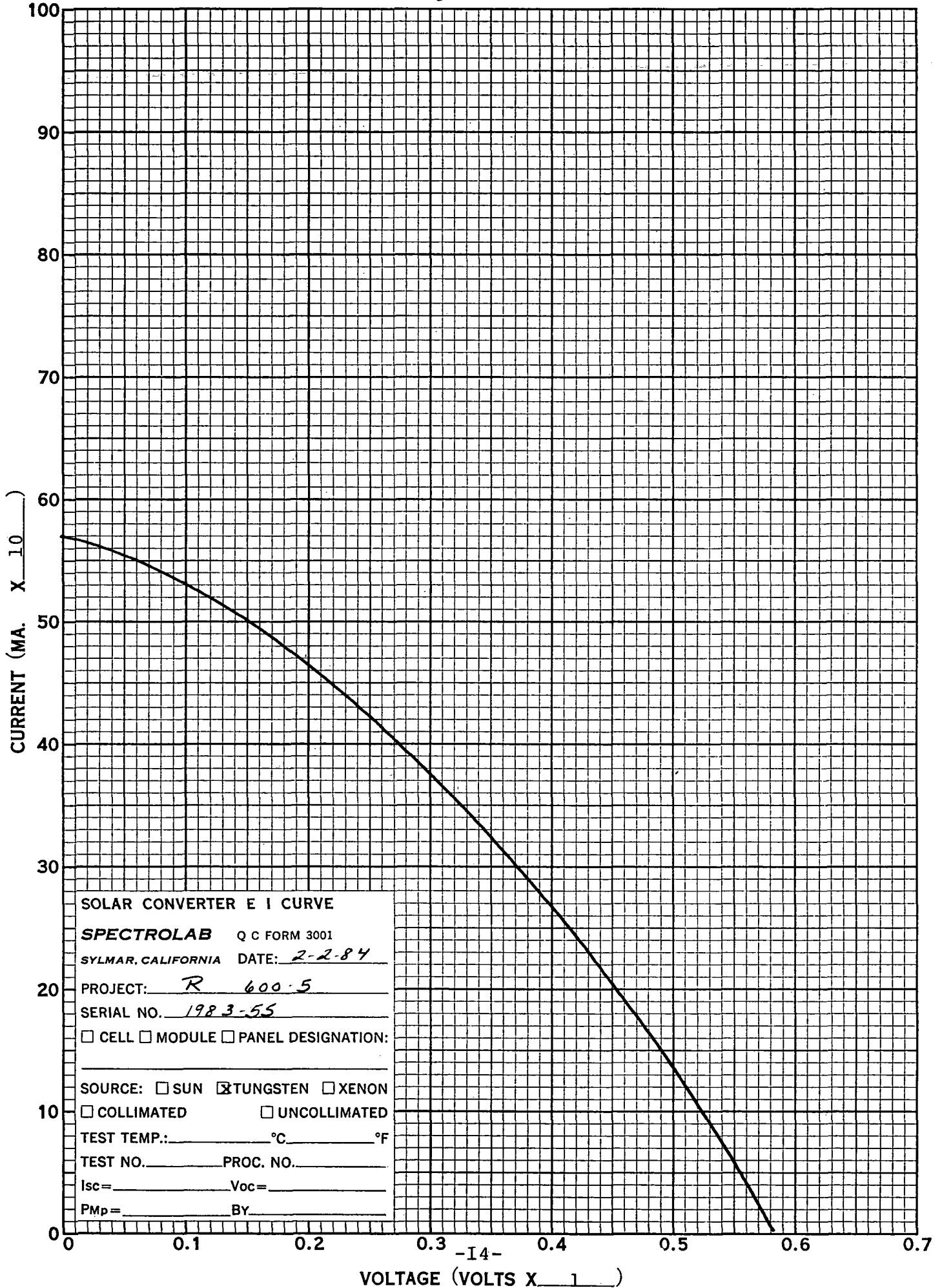
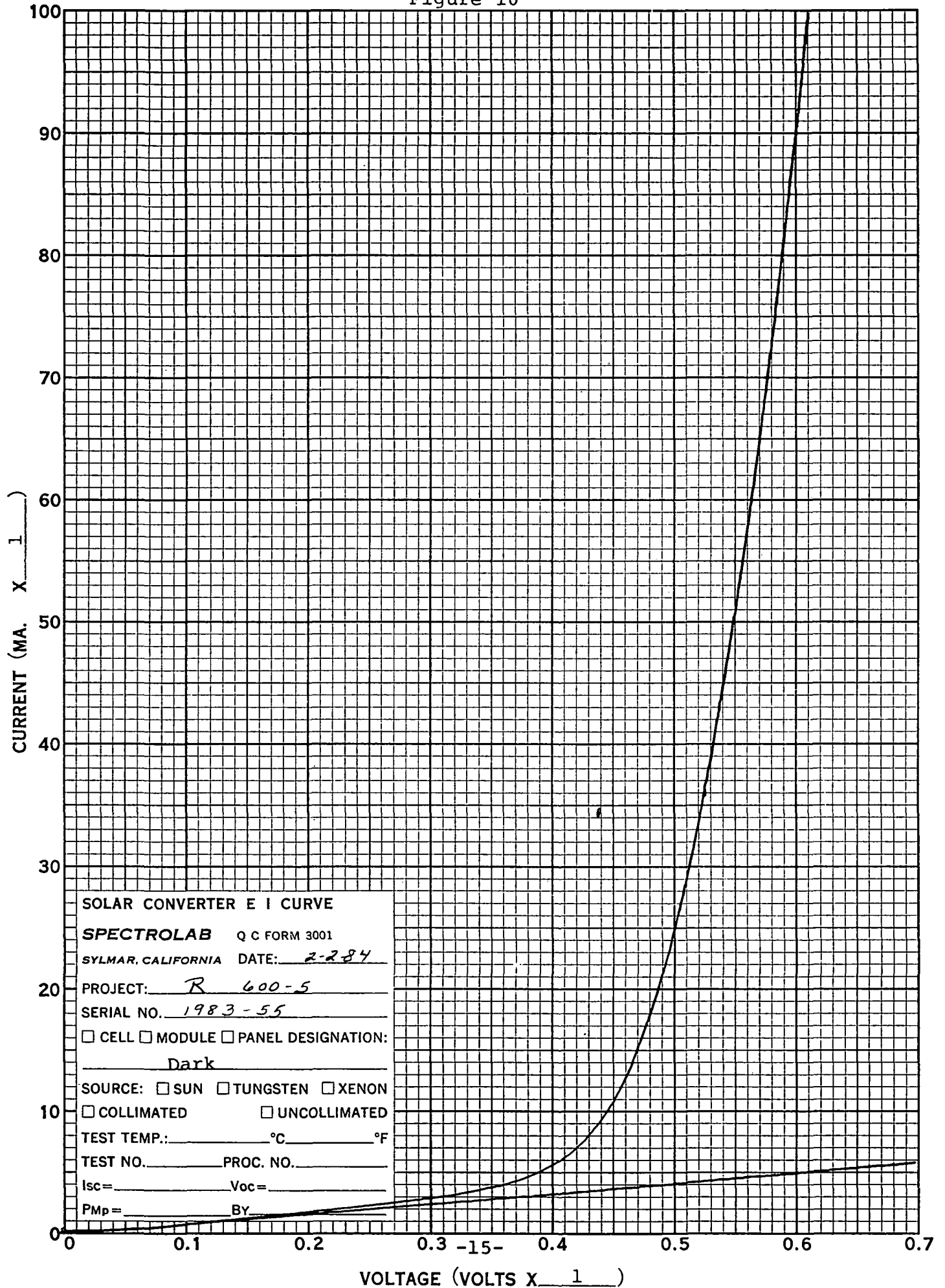


Figure 10



CONTROLLED ATMOSPHERE SCANNING ELECTRON MICROSCOPY

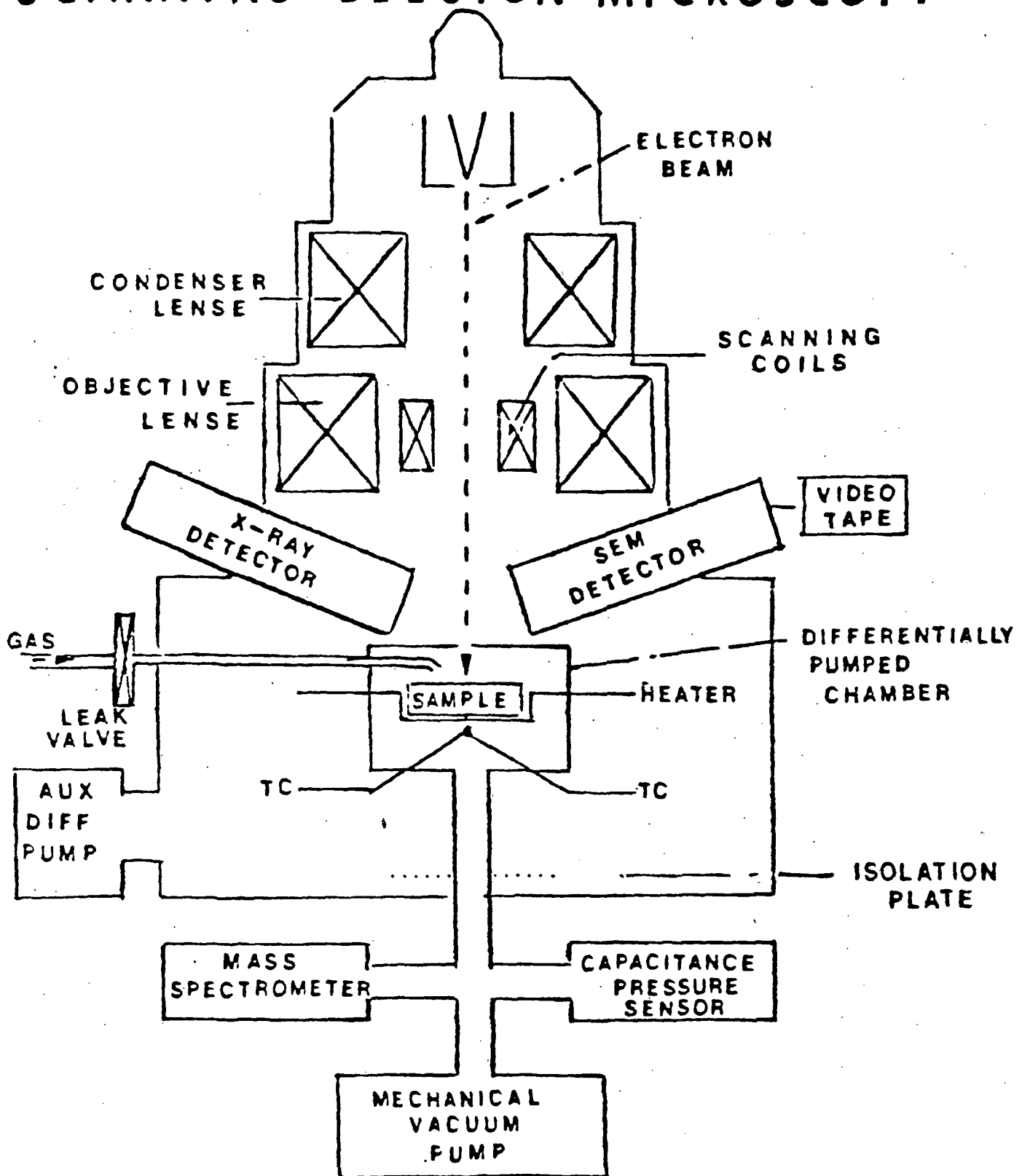


Figure 11
MICROSCOPY RESEARCH LABORATORIES, INC.

Figure 12

PASTE J, 3000X, PRIOR TO HEATING

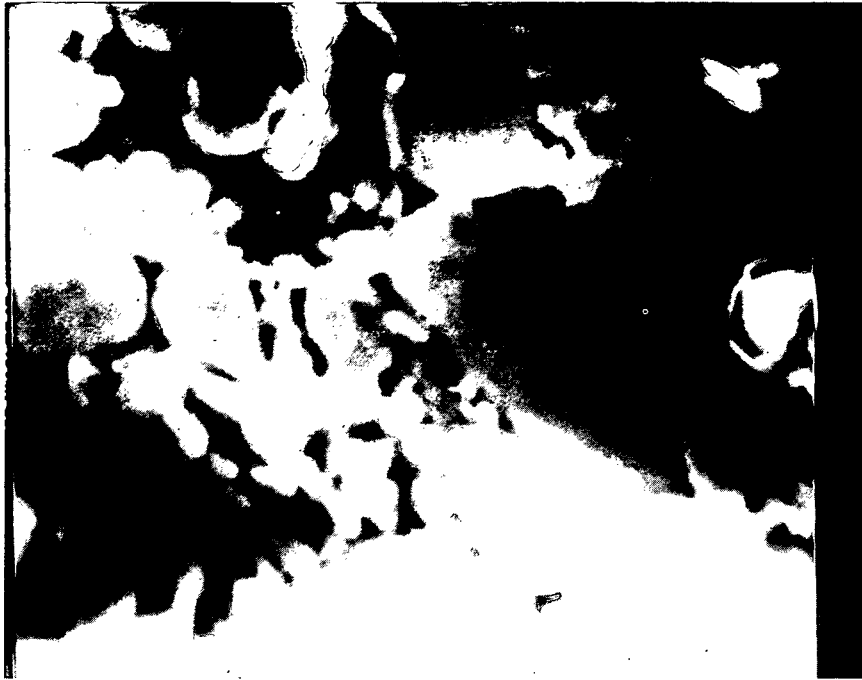
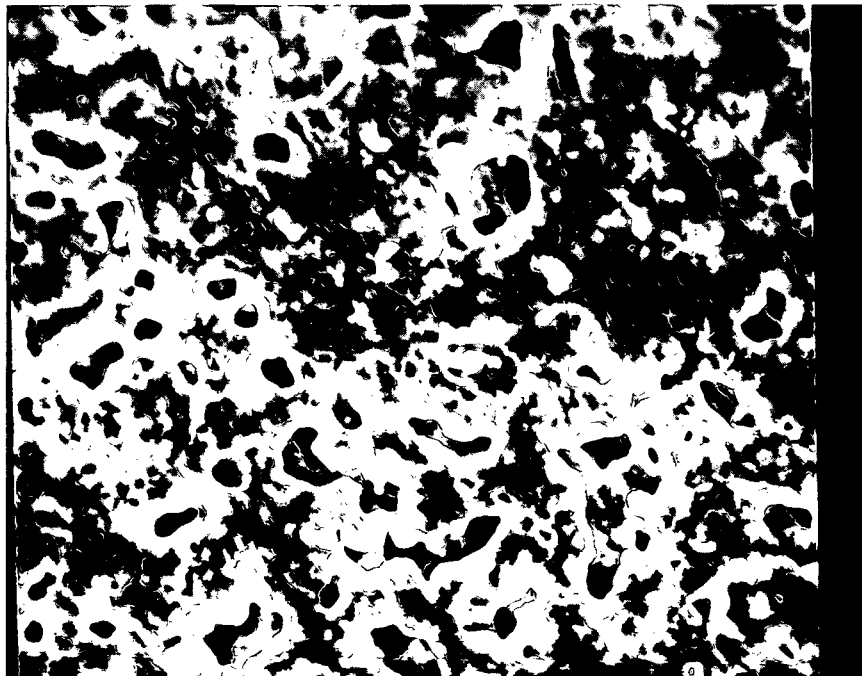


Figure 13

PASTE J, 3000X, AFTER HEATING



Section 3.0

CONCLUSIONS AND RECOMMENDATIONS

There are no conclusions or recommendations to report for the period.

Section 4.0

ACTIVITIES PROJECTION

During the next quarter additional pastes will be evaluated. Work on the two-step process will continue and the molybdenum oxide paste will be reevaluated.